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Suppliers' Information Note

For The Openreach Network

Ethernet Access Direct (EAD) inc EAD Sensitive 10000

Service & Interface Description

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CONTENTS

1. Introduction 3
2. Service Description 3
3. EAD 10000 Service Features 7
   3.1 General 7
   3.2 Frame Forwarding Behaviour 7
   3.3 EAD 10000 Transparency Restrictions 7
   3.4 Auto-Negotiation and Duplex Settings 8
   3.5 Link Loss Forwarding 8
      3.5.1 Network Link Loss Forwarding 8
      3.5.2 User-User link Loss Forwarding 8
   3.6 Synchronous Ethernet with PTP T-BC on path support (Traffic port only) (PTP not available on EAD Sensitive) 9
   Timing Input Options 11
4. Customer Interfaces 13
   4.1 General 13
   4.2 Connector 13
5. Transmission 14
6. Environmental Specifications 14
7. Power Supply 15
   7.1 General 15
   7.2 Installation and Testing 15
   7.3 AC Power connection 15
   7.4 DC Power Connection 15
      7.4.1 Customer-provided wiring up to the Openreach specified In-Line Connector 16
   7.5 Additional Details 16
8. Further Information 16
9. References 17
10. Abbreviations 17
11. History 18

FIGURES

FIGURE 1. EAD 10000 SERVICE CONFIGURATION.....5
FIGURE 2. EAD 10000 LOCAL ACCESS SERVICE CONFIGURATION.....6

FIGURE 3.1U XG120 VARIANT DEMONSTRATING THE 3 x INDIVIDUAL 10G SERVICES 6

TABLES

TABLE 1. CLIENT INTERFACES.....4

TABLE 2. MULTIMODE CABLE OPERATING DISTANCES.....13

1. Introduction

This Suppliers' Information Note (SIN) describes the interface provided with the Openreach 10 Gbit/s Ethernet Access Direct (EAD) services, referred to as EAD 10000. Also provided is some general information on the EAD product family and some physical aspects of the NTE being deployed for Ethernet Access Direct 10000 customer orders.

EAD services are high speed, point-to-point data circuits that are permanently connected and available 24 hours a day, 365 days a year. EAD provides secure links between combinations of end user sites, Communications Providers' (CPs') sites and BT exchanges. The EAD Local Access product provides a secure link between an end user site or a CP site and the fibre serving BT exchange site, with the circuit terminating at a CP presence at that serving exchange (e.g. BT Locate space).

Any specific technology mentioned in this document is current as of today. However, it may be subject to change in the future. Should the specification of the interface be changed, this will be notified by a new issue of this SIN. Openreach reserves the right to adapt technology to deliver EAD and EAD Local Access services as new developments are made. All services are delivered over an uncontended transmission path.

IMPORTANT:- Please refer to Customer Handbook with regards to safety information for the fibre management tray

2. Service Description

The EAD service is a point-to-point data service offering high bandwidth connectivity over a standard radial distance up to 25km (23km for EAD sensitive) between sites. This

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radial (or point-to-point) distance can result in physical line plant route distances of up to 40 km (36km for EAD Sensitive).

There are following variants on EAD 10000:

- 1U XG210 NTE which offers single 10G service
- From April 2021, the new 1U XG120 slim line multi-service head end will offer upto 3 x individual 10G services as shown in Figure 3 below.

Extended Reach options (i.e. above 40km radial distance) are not available for EAD 10000 circuits. EAD offers to provide a secure link between a combination of end user sites, Communication Provider's (CP's) network at a CP's sites and BT exchanges, with the circuit terminating at a CP presence at that serving exchange (e.g. BT Local space).

Synchronous Ethernet (SyncE) with Precision Time Protocol (PTP) [14] is an optional feature of the EAD service available via the Openreach EMP platform only, PTP is not available for EAD Sensitive. SyncE with PTP is available for EAD 10000 services for Local Access and Standard Reach, including Resilience Options. However on the new XG120 slim line multi-service headend only Resilience Option 2 is available. Resilience Option 1 will not be available on XG120.

EAD SyncE with PTP will transport a clock input through the network to produce a matching clock output at the other end of the service. Providing and maintaining the timing source is the CP's responsibility.

EAD Local Access only provides access as far as the fibre serving exchange and, as this is the only exchange involved, radial distances between exchanges are not applicable. EAD Local Access provides a secure link between either an end user site or Communication Provider's (CP's) network at a CP's site and the fibre serving BT exchange site, with the circuit terminating at a CP presence at that serving exchange (e.g. BT Locate space).

For enquiries concerning connection availability between particular sites and for further information on the EAD service please contact your Openreach Sales Relationship Manager or refer to the EAD/EAD Sensitive Product description, available on the Openreach web site.

The client interfaces offered on the 10Gbit/s EAD services (including SyncE), i.e. the NTE are shown in the table below. The interfaces are based on LAN PHY as described in 802.3 [2]

Product Selected	**EAD/EAD Local Access 10000**
Interface(s) Offered	10GBase-LR (SMF) (10 Gigabit Ethernet LAN PHY) 10GBase-SR (MMF) (10 Gigabit Ethernet LAN PHY)

	10GBase-BR10 (SMF)* (10 Gigabit Ethernet LAN PHY)
Connector Types	Dual LC (applicable to 10GBase-LR, 10GBase-SR) Single LC (applicable to 10GBase-BR10)

Table 1. Client Interfaces

***NOTE:** In addition, the new XG120 Slim line NTE will be available with single fibre 10GBase-BR10 handover to the customer.

Client interfaces offered on the EAD 10000 NTE are Full Duplex only in line with IEEE standards for 10Gbit/s Ethernet. The uncontended transmission path is routed via the Openreach network.

A schematic of the EAD 10000 service is shown in Figure 1 and EAD Local Access is shown in Figure 2. The diagrams depict current technology and delivery, and this is subject to change. In each case the management router will normally be located at the A end, but in certain circumstances may be located at the B end, but possibly at both ends particularly for XG120 deployment.

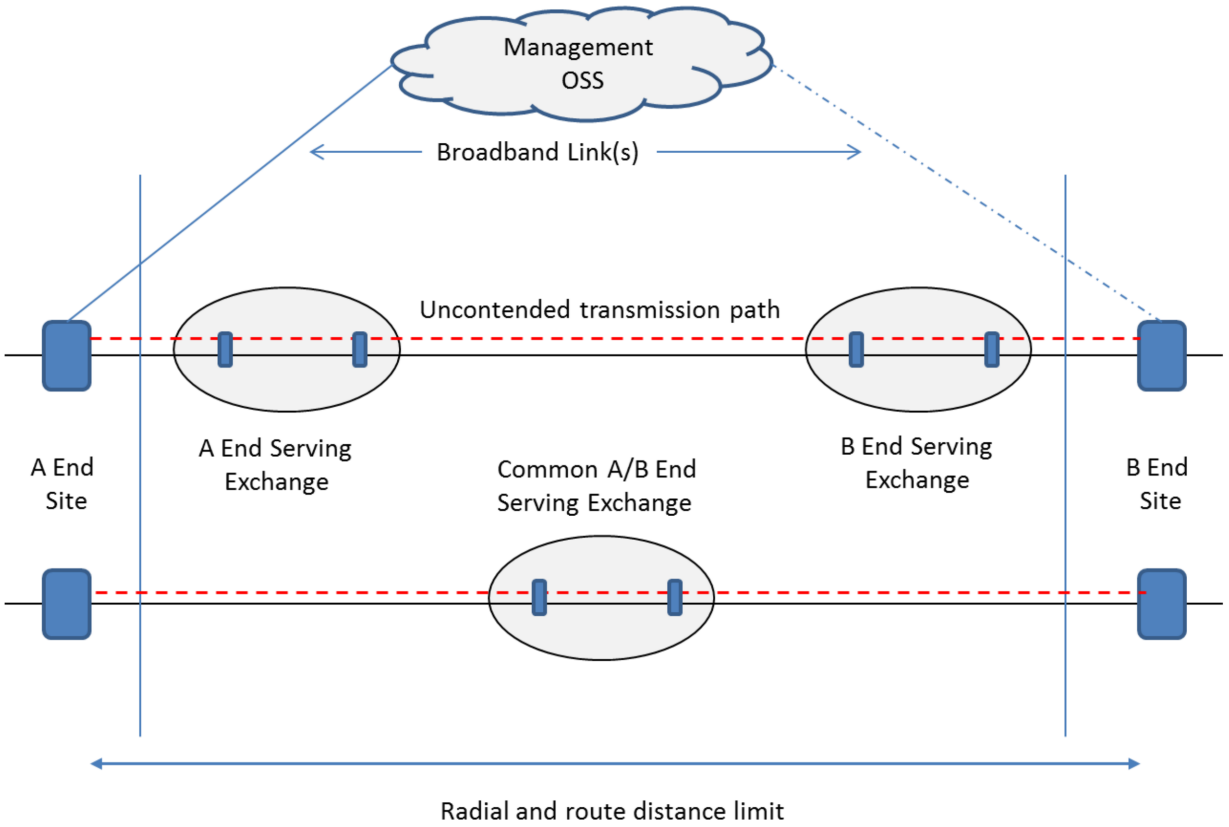

Figure 1. EAD 10000 Service Configuration

NOTE:

- Figure 1 depicts two separate circuit scenarios, not a combined service. The upper schematic represents an EAD circuit where each end is served from different BT exchanges. The lower schematic represents an EAD circuit where each end has a common BT serving exchange.
- EAD Sensitive has no Management OSS application

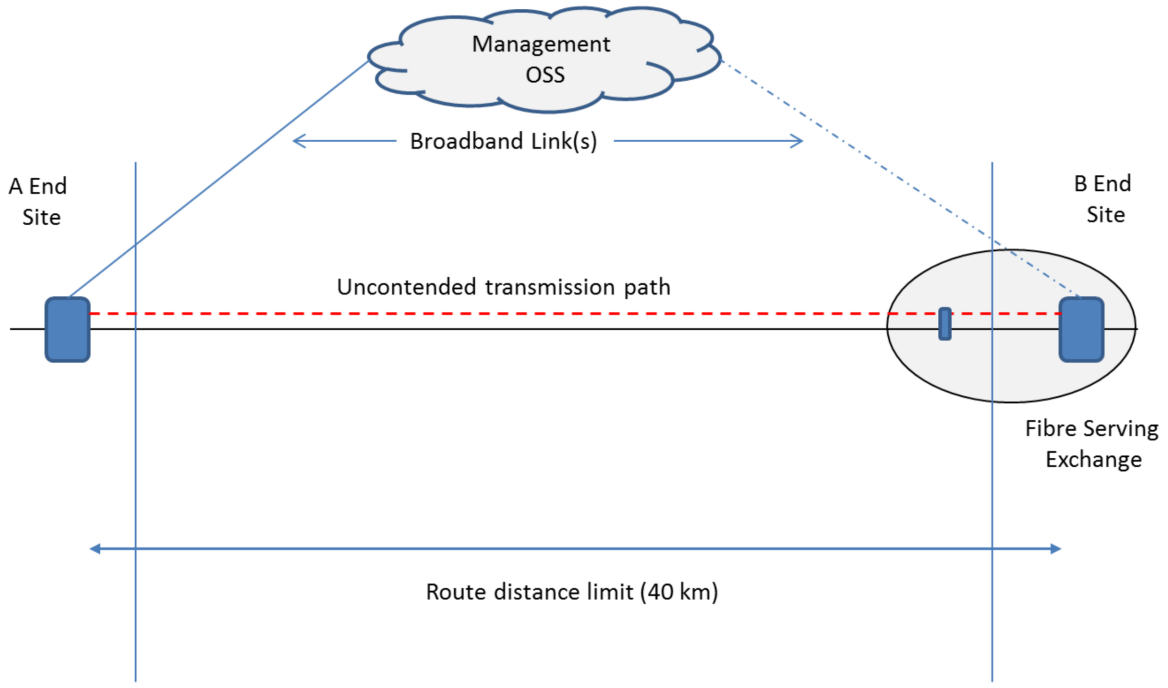

Figure 2. EAD 10000 Local Access Service Configuration

The EAD/EAD Local Access services are connected for operational support purposes to an Openreach management platform.

NOTE: EAD Sensitive has no Management OSS application

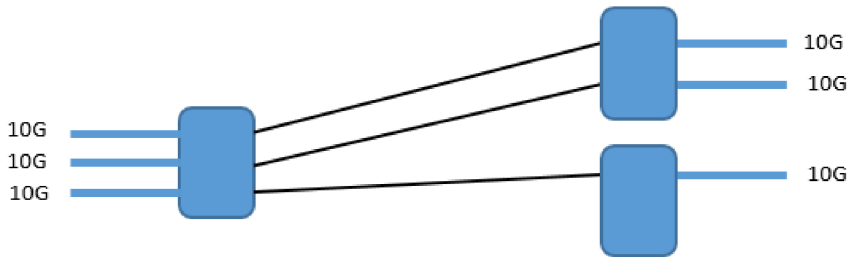

Figure 3: 1U XG120 variant demonstrating the 3 x individual 10G services

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3. EAD 10000 Service Features

3.1 General

The 10G EAD NTE is capable of transmitting frames conforming to IEEE 802.3 [2] with frame sizes from 64 bytes to a maximum of 2000 bytes. This is to maintain compatibility with a number of frame tagging formats, including VLAN tagging as specified in 802.1Q [4].

The service is transparent to VLAN tags and will forward VLAN tagged frames in the same way as standard (untagged) frames.

On a 10Gbit/s SyncE/PTP enabled service (PTP not available on EAD Sensitive) one additional frame per second will be sent with the customer traffic on the same remote end access port to provide information on the status of the synchronisation.

On XG210, Due to the use of a 4 byte overhead for management purposes an EAD 10000 circuit is expected to have a reduction of throughput of up to 1% for Customer frame sizes of 400 bytes and above. For customer Ethernet frame sizes smaller than 400 bytes the throughput reduction increases to approximately 6% for 64 byte frames.On Slim line multi service chassis XG120, CPs will get 99.9% throughput for all frame sizes with the ability to send untagged, single tagged and double tagged frames. Customers will be able to send out VLAN tags in range 0-4094 (both inclusive). VLAN 4095 will be reserved for internal management thus cannot be used by the Customer.

EAD Sensitive is offered with the XG120 Slim line head end, the Intelectual Property of which is owned by ADVA, the PCB design was completed in the USA. Software development, software integration and verification testing was undertaken in the USA and Poland.

NOTE: The EAD 10000 NTE will pass 9000 byte frames, however as this is not yet a recognised Ethernet standard BT will not validate usage at this level until such time as the IEEE provide an endorsement and published standard for jumbo frames and we have tested against it.

3.2 Frame Forwarding Behaviour

The EAD 10000 service does not include IEEE 802.1d [3] Bridging functionality, which allows for the Learning and Filtering of traffic packets destined for those hosts connected at the local end.

Therefore Ethernet frames that would normally be filtered by 802.1d [3] bridging functionality are instead forwarded across the EAD link.

3.3 EAD 10000 Transparency Restrictions

All Ethernet frames are passed across the EAD link, other than the following list of

known exceptions:

1. Transport of EFM OAM PDUs as defined by IEEE 802.3 [2] over EAD is not supported.

   The EAD service uses EFM OAM PDUs internally for the purposes of OAM. And as per the IEEE 802.3 [2] standards defined behaviour for EFM equipment, the end to end transport of customer EFM OAM PDUs over the EAD link is blocked.

2. Transport of Ethernet flow control / Pause frames over EAD is not supported.

3. IEEE 802.1ag [1]/ITU-T Y.1731 [10]) is transparent as long as the Customer does not use MD levels 0 or 1. (does not apply to XG120 NTE)

3.4 Auto-Negotiation and Duplex Settings

In contrast to lower rate Ethernet signals (10, 100 and 1000Mbit/s) the 10Gbit/s Ethernet service, in line with standards, does not support auto-negotiate to advertise speed and duplex settings. Instead the speed is set to 10Gbit/s and the service is "Full Duplex". Half duplex operation is not supported.

3.5 Link Loss Forwarding

The EAD 10000 NTE is offered with both Network Link Loss Forwarding and user Link Loss Forwarding. Network Link Loss Forwarding is applied to the network service by default. The User Link Loss forwarding is a selectable option, as is the link failure direction (i.e. A to B end or B to A end).

3.5.1 Network Link Loss Forwarding

When a break is detected on the Openreach network link, the client interface port is shut down to indicate the state of the infrastructure. This continues until such time as the network break is repaired.

NOTE: On XG120, Access ports that take in the Sync timing feed from the customer will not have port down LLF fault propagation, because this would disconnect the incoming timing feed, that is used for other services.

3.5.2 User-User link Loss Forwarding

User-User Link Loss Forwarding allows the notification of failure of an NTE at one end of

an EAD 10000 service to be propagated to a suitably configured customer device at the other end of the same service. Available as a selectable unidirectional service only, User Link Loss Forwarding is notified at the time of provision.

For EAD customer to CP connections, it is recommended that this functionality is activated from the CP's PoP to the End User customer site. This means that the EAD circuit is only impacted by User Link Loss Forwarding only if problems occur at the CP's equipment at the CP PoP site end of the circuit. If problems occur at the end user customer's equipment, the circuit will not be impacted.

Where User-User Link Loss Forwarding is present on an EAD 10000 service the intrusive remote test may not operate correctly unless active ethernet port connection is made at both ends of the service. Also for Intrusive remote test to work correctly there must not be any active Customer traffic passing through the ports

Note: On XG120, Access ports that take in the Sync timing feed from the customer will not have port down LLF fault propagation, because this would disconnect the incoming timing feed, that is used for other services. LLF direction from remote NTE towards headend NTE will not be offered on the access ports that take in Sync timing feed.

3.6 Synchronous Ethernet with PTP T-BC on path support (Traffic port only) (PTP not available on EAD Sensitive)

For the EAD 10G service, Synchronous Ethernet (SyncE) with Precision Time Protocol (PTP) is an optional feature which will transport a clock source, provided by the CP, across the service to enable time and phase recovery. Both features (SyncE and PTP) are either enabled or disabled. Customers cannot select to only take one feature without the other.

The different Synchronised Ethernet with PTP circuit order types, i.e. whether a service has input timing feed, transports across the network link and/or output timing feed back to customer at the remote site, is detailed in the customer handbook.

From April 2021 the NextGen EAD service will transport a clock input from the headend through the network to produce a matching clock output at the other end of the service. Providing and maintaining the timing source is the CP's responsibility. This service supports;

- Synchronisation at the Physical layer, ITU-T G.8261 [6]
- Supports clock requirements at as specified in ITU-T G.8262 [7]
- Supports messaging requirements as specified in ITU-T G.8264 [8]
- Supports full timing support as specified in ITU-T G.8275.1 [12]
- Supports boundary clock as specified in ITU-T G.8273.2 [13]
- Multiple timing domains on the NTE are not supported

This SyncE with PTP feature can be specified at time of service order or added later as a modify.

For the headend and remote NTE, Synchronous Ethernet (SyncE) with Precision Time Protocol (PTP) is an orderable feature which will transport a clock source, provided by the CP, across the service to enable time and phase recovery.

The CP will be responsible for providing and maintaining the timing source.
A maximum of three traffic ports may be used for input clock feeds (i.e. a primary, secondary and tertiary) per headend NTE. Only one timing domain is available per XG120 Slimline NTE.

The synchronisation output at the far end of the service will be on the Ethernet traffic port. At the local end - the secondary or tertiary feeds will only be used in order in the event of failure of the primary clock / secondary clock feed from the CP. The CP will be responsible for providing and maintaining the timing source.

The BITS-In frequency port on the headend NTE is not supported.

The EAD service supports Synchronous Ethernet as specified by ITU-T G.8261, ITU-T G.8262 and ITU-T G.8264 and Precision Time Protocol as specified by IEEE 1588v2 and ITU-T G.8275.1 Time and Phase Standard. Openreach EAD product is a PTP aware Telecom Boundary Clock, supporting full on Path Support (SyncE ITU-T G.8261, ITU-T G.8262, ITU-T G.8264 and PTP ITU-T G.8275.1).

The EAD service does not provide the Primary Reference Time Clock (T-GM) or traceability back to the PRTC for both Phase/Time and Frequency traceability, but is only transporting Time and Phase with respect to the ITU-T G.8275.1 Telecom Profile standard.

It is the responsibility of the CP to provide Time and Phase Traceability back to their PRTC in their network. Traceability Flags are used as part of the PTP messages to convey status and indicate whether the T-BC is traceable back to the PRTC, or whether traceability has been lost. If the traceability flag indicates that the PTP flow is no longer traceable back to the PRTC, then this PTP Port/Flow would no longer be considered as valid reference input to the Openreach Equipment.

The standards that the Customer needs to adhere to are as below:

ITU-T G.8275.1

ITU-T G.8261

ITU-T G.8262

ITU-T G.8264

The ITU-T G.8275.1 Time and Phase Standard defines the full on-path protocol for the delivery of Frequency and Phase/Time. It is based on point to point Ethernet multicast communication between adjacent nodes (IP not supported by the profile).

When G.8275.1 ITU-T T-BC is configured, 384kbps of bandwidth is automatically

allocated for the PTP Flow and all PTP Messages on all Ports that are participating in the T-BC configuration. Hence there is a slight reduction in traffic throughput with SyncE and PTP enabled. For example, where the link is used to transport 10G traffic, the maximum circuit throughput is 9,999,296,000bps, due to an additional 384kbps overhead for Sync traffic.

VLAN Tags shall not be used with the Boundary Clock PTP Flow (G.8275.1 uses Multicast) – regardless of traffic tagging. The CP shall send in PTP un-tagged to the headend NTE.

There will be Openreach Portal available to the customer for the EAD10000 service. Additional alarm notifications to the customer are a "PTP clock time not traceable" alarm. Time holdover is expected to be at least 1 hour for Boundary clock. Frequency SyncE holdover may be a number of hours.

On a SyncE/PTP enabled service, one additional frame per second will be sent with the customer traffic on the same remote end access port to provide information on the status of the synchronisation client interface. For the PTP component, 40 packets per second will be sent with the customer traffic on the same remote end access port to provide information on the status of the synchronisation client interface.

Timing Input Options

The customer traffic port is the only supported Synchronisation Input option. The timing feed(s) should be fed into the matching circuit access port on the circuits that have been ordered with Phase/Sync. The Synchronisation output will be on the traffic port of all circuits 10G and remote rugged NTEs as per customer order.

SyncE

SyncE Feature	Openreach	Customer
SyncE	Yes	Yes
ESM Channel	Yes	Yes
QL Mode	Yes	Yes

PTP Telecom-Boundary Clock Configuration

PTP Telecom-Boundary Clock Configuration Feature	Openreach	Customer Settings

T-BC	Enabled	T-BC Enabled
PTP Clock Profile	G.8275.1	G.8275.1
PTP Clock Type	Boundary Clock	BC
PTP Clock Domain	24	24
Priority 1	128	128
Priority 2	128	128
Local Priority	128	128

PTP Port Configuration

Feature	Openreach	Customer Setting
Master Clock Type	One Step	One Step
Local Priority	128	128
Master /Slave	Slave (Sync input feed port) Master (Sync output port)	Master (CP setting at sync input feed port) Slave (Customer setting at sync output port)
Dest. MAC ADD.	Forwardable	Forwardable
Sync Message Rate	16pps	16pps
Delay Req/Resp Message Rate	16pps	16pps
Announce Message Rate	8pps	8pps
Announce Receipt timeout	8 intervals	8 intervals
Sync Receipt timeout	16 intervals	16 intervals
Delay Response Receipt timeout	16 intervals	16 intervals

Openreach EAD 10G Phase/Sync service conforms to the Class A T-BC clock as per G.8273.2 and has a max absolute time error of 100ns.

The Openreach service has 2 x T-BC therefore the Openreach service max absolute time error is 200ns.

4. Customer Interfaces

4.1 General

The customer equipment Ethernet interface must conform to IEEE 802.3[2]. The following two interfaces are supported:

10GBASE-SR, [850 nm multimode serial LAN PHY]

10GBASE-LR, [1310 nm single-mode serial LAN PHY]

10GBASE-BR10-U, [1270nm single-mode serial LAN PHY]

4.2 Connector

The client interface is the Network Termination Point (NTP), i.e. the point of connection on the Openreach Network Terminating Equipment (NTE) for connecting CPE or CP equipment. This is the Service demarcation point between the Openreach network and the customers' equipment.

The client interface consists of dual LC sockets for 10GBASE-SR and 10GBASE-LRas specified in the IEEE 802.3[2] specifications.

The client interface also consists of single LC sockets for 10GBASE-BR10-U as specified in the IEEE 802.3cp [15] specifications.

The CP or End User provides the suitable connecting cords between the NTE and their own equipment. For multimode fibre cabling used on the 10GBASE-SR interface, this is limited to a maximum cable length based on the bandwidth specification of the multimode cable:

Multimode cable bandwidth (MHz•km)	Operating Distance (m)
160	26
200	33
400	66
500	82
2000	300

Table 2. Multimode cable operating distances

For single-mode fibre cabling used on the 10GBASE-LR interface, this is limited to a maximum cable length of 10000 metres.

For single-mode cabling used on the 10GBASE-BR10 interface, this is limited to a

maximum cable length of 10000 metres. Openreach will transmit at 1270 nm wavelength using a Bi-Di SFP+ and CPs will have to transmit at 1330nm wavelength using Bi-Di SFP+ compliant to interface type 10GBASE-BR10-D as specified in IEEE 802.3cp expected to be approved by mid 2021.

5. Transmission

The NTEs connected to the Openreach network provide an uncontended transmission path.

6. Environmental Specifications

The Temperature and humidity range of the environment used to house the XG210 NTE must not exceed the following:

- Ambient room temperature: 0°C to +40°C
- Relative humidity 5% to 95%
- Active Cooling

The dimensions of the 1U high NTE are (443mm x 44.4mm x 220mm WxHxD)

Weight 5.6 kg

The Temperature and humidity range of the environment used to house the XG120 multi service NTE (carrying EAD 10G services only) must not exceed the following:

- Ambient temperature: -20°C to +60°C
- Relative humidity 5% to 95%
- Active Cooling

The dimensions of the 1U high DC NTE are (443mm x 43.6mm x 205.5mm WxHxD)

Weight of DC NTE is 4.3 kg

The dimensions of the 1U high AC NTE are (443mm x 43.6mm x 366.6 mm WxHxD)

Weight of AC NTE is 6.8 kg

Please refer to the EAD product description for details of physical space requirements.

EAD product description can be found at:
https://www.openreach.co.uk/orpg/customerzone/products/ethernetservices/ethernet

accessdirect/description/productdescription.do

7. Power Supply

7.1 General

By placing an order with Openreach the customer has accepted the conditions placed by BT in relation to providing power, as defined below:--

In relation to powering of equipment, the customer must comply with the requirements of BS7671 [11] and the details given within the "DC Power Planning and Installation Guide for WES-BES Products' document.

The Openreach NTE is locally powered and offers AC or DC power options. The CP will be required to provide either dual local 50Hz AC supply in the form of standard 13 Amp power socket(s); or dual -48 V DC power distributions and Earth connections, with all wiring colour schemes conforming to BS7671 [11] . It will be the customer's responsibility to ensure that the power supplies are fused and safe for Openreach to use. These should be in close proximity to the NTE installation location.

7.2 Installation and Testing

In addition to the NTE powering requirements (i.e. AC or DC power as defined below), a spare 50 Hz AC mains supply 13A socket should also be provided in close proximity to the NTEs' to power BT test equipment during both initial commissioning and subsequent maintenance support activities. A 50 Hz mains supply 13A socket should also be provided in close proximity to the NTE for the management router. The new XG120 Slim line multiservice NTE will require a management router connection if it is designated a hub end. Remote end XG120 NTEs (i.e. without a management router connection) will require their first provisioned circuit to have the other end of that circuit connected to a hub end XG120 for management purposes.

7.3 AC Power connection

AC power connection between Openreach equipment and the power socket will be made using a power lead fitted with a standard 13A plug, this is Low Smoke, Zero Halogen. The NTE itself has dual power supply units internally, and requires two AC mains supply sockets running off the same phase.

For most installations, this will require two mains connections for each NTE provided, and the consumption of the Openreach NTE in this managed service arrangement will typically be 63 watts per NTE. An additional AC mains supply socket will be required for the management router.

7.4 DC Power Connection

The DC in-Line (Molex) connector is specified as the standard method of connecting DC power by Openreach, and represents the "Demarcation Point" between Openreach and the customer. At is site the customer is required to provide suitable power and earth connection to, and be responsible for the supply, wiring and labelling to, the demarcation point. Openreach will not supply or install the DC distribution system as part of the standard Ethernet installation.

EAD Sensitive is also provided with this DC In-Line (Molex) lead, which is not Low Smoke, Zero Halogen.

7.4.1 Customer-provided wiring up to the Openreach specified In-Line Connector

Wiring, MCB isolation or fuse (i.e. C type MCB or Cartridge Fuse) must be provided by the customer, up to and including the DC in-line connector, as per BT's requirements stated within the DC Power Planning and Installation Guide for WES-BES Products document with respect to;

i. Correctly rated MCB/Fuse,
ii. Correct labelling of wiring and MCB/fuse positions compliant with BS 7671 [11]
iii. Correct size of cable for required voltage drop at required maximum current
iv. Separately fused isolatable A & B power supplies, as detailed in the 'AC/DC Power Planning and Installation Guide' document

An additional AC mains supply socket will be required for the management router. Currently the management router is AC powered only.

7.5 Additional Details

For further details on the provision of DC power see the 'AC_DC_power_planning_installation_issue_11' available on the Openreach Ethernet website.

If there is a conflict between DC power information contained in the 'AC/DC Power Planning and Installation Guide' and the SIN document, the order of precedence shall be as follows:

(a) AC/DC Power Planning and Installation Guide
(b) SIN

8. Further Information

For enquiries concerning connection availability between particular sites and for further "sales and marketing" information on EAD 10000 services, please contact your Openreach Sales Relationship Manager or see the Openreach site listed on the SINet

Useful Contacts page at
https://www.openreach.co.uk/orpg/home/helpandsupport/sins/sins.do

9. References

[1]	IEEE 802.1ag	Connectivity Fault Management	2007
[2]	IEEE 802.3	IEEE Standard for Ethernet	2015
[3]	IEEE802.1d	IEEE Standard for Local and metropolitan area networks: Media Access Control (MAC) Bridges	2011
[4]	IEEE 802.1Q	IEEE Standard for Local and metropolitan area networks—Media Access Control (MAC) Bridges and Virtual Bridges	2012
[5]	SIN 432	Openreach Wholesale Extension Services 10 and Wholesale end-to-end services Local Reach (WES/WEES 10LR)	2009
[6]	ITU-T G.8261	Timing and Synchronisation Aspects in Packet networks	2013
[7]	ITU-T G.8262	Timing Characteristics of a synchronous Ethernet equipment slave clock	2015
[8]	ITU-T G.8264	Distribution of timing information through packet networks	2017
[9]	ITU-T G.703 (2M)	Physical/electrical characteristics of hierarchical digital interfaces	2016
[10]	ITU-T Y.1731	OAM functions and mechanisms for Ethernet based networks	2015
[11]	BS7671	Requirements for electrical installations. IEE Wiring Regulations. Eighteenth edition	2016
[12]	ITU-T G.8275.1	Precision time protocol telecom profile for phase/time synchronization with full timing support from the network	2016
[13]	ITU-T G.8273.2	Timing characteristics of telecom boundary clocks and telecom time slave clocks for use with full timing support from the network	2017
[14]	IEEE 1588-2008	IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems	2008
[15]	IEEE-802.3cp	IEEE Standard for Ethernet Amendment: Bidirectional 10 Gb/s, 25 Gb/s, and 50 Gb/s Optical Access PHYs	2021

For further information or copies of referenced sources, please see document sources at: http://www.btplc.com/sinet/Documentsource/index.htm

10. Abbreviations

10Gbase-LR	10 Gbit/s Ethernet over Fibre for LAN, Long Reach interface as defined in 802.3
10Gbase-SR	10Gbit/s Ethernet over Fibre for LAN, Short Reach interface as defined in 802.3
BITS	Building Integrated Timing Supply
bps	BITS per second
CP	Communications provider (Providers of Electronic Communication Services)
CPE	Customer Premises Equipment
EAD	Ethernet Access Direct
EFM	Ethernet in the First Mile
EMP	Equivalence Management Portal
ESM	Ethernet Synchronisation Message
Gbit/s	Giga (10^9) bits per second
IPR	Intellectual Property Rights
ITU-T	International Telecommunications Union for Telecommunications (formerly CCITT)
kbps	Kilo BITS per second
LAN	Local Area network
LLF	Link Loss Forwarding
MAC	Media Access Control (& hardware Device Address)
Mbit/s	Mega (10^6) bits per second
MCB	Mini Circuit Breaker
MDI	Media Dependent Interface
MMF	Multi-Mode Fibre
NTE	Network Terminating Equipment
NTP	Network Terminating Point
OAM	Operations Administration and Management
PDU	Protocol Data Unit
SIN	Suppliers' Information Note
SMF	Single Mode Fibre
SSM	Sync Status Message
VLAN	Virtual Local Area Network

11. History

Issue	Date	Details
1.0	July 2015	First issue
2.0	November 2018	New section 3.7 Synchronous Ethernet with PTP T-BC on path support (Traffic port only)
3.0	July 2019	Additional text in section 3.7 confirming T-BC performance
4.0	Mar 2021	Added XG120 variant to product portfolio
4.1	March 2022	Reference to EAD Sensitive

4.1	April 2023	Annual Review – branding and font changes only – issue remains unchanged.
4.1	February 2025	Annual Review – branding and font changes only – issue remains unchanged.

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